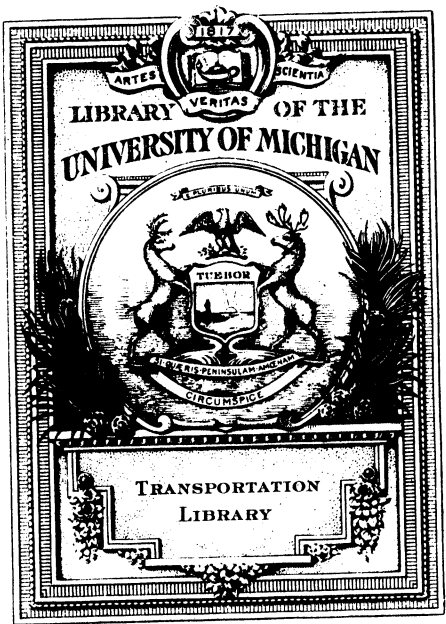
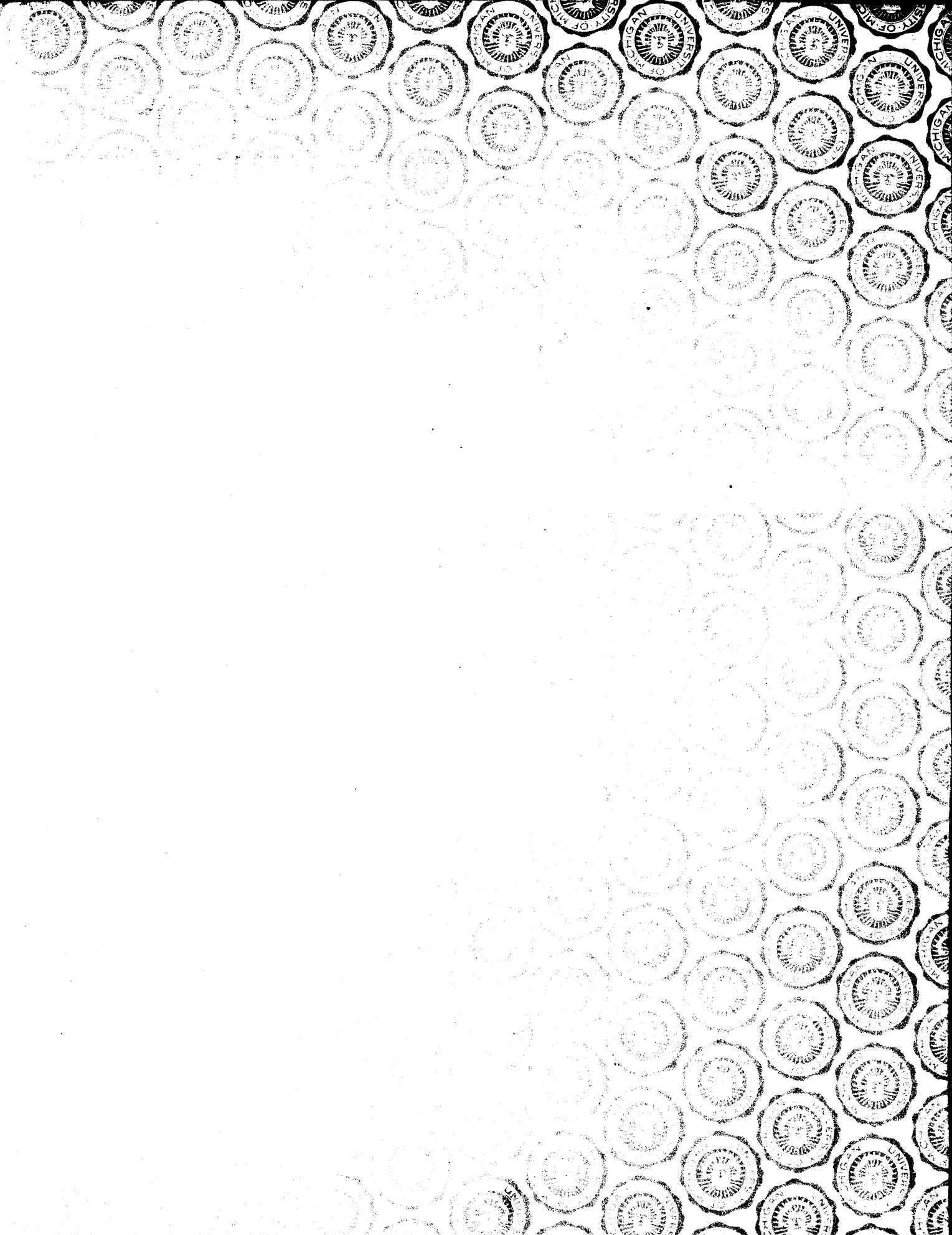


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ANIMADVERSIONS

ON THE USE OF

BROAD WHEELS,

THE slight remarks, inserted in the last part * of my Observations on the Structure and Draught of Wheel-carriages, have led, it seems, many persons to conceive that I meant to recommend the unlimited use of broad-wheels, as tending universally to the preservation of the roads, provided it could be reconciled to the profit and convenience of the proprietors of such carriages. This misconception hath occasioned many of the interested and curious to honour me with their enquiries, respecting the result of my experience and information on this subject. The desire, which, from duty as well as inclination, I entertain, to give the publick all the satisfaction in my power,

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hath

* See Part iv. Sect. 4. of Observations on the Structure and Draught of Wheel-carriages by J. Jacob. printed for Mess. E. and C. Dilly in the Poultry London. 4to. price Six Shillings.

hath induced me, therefore, to publish the following animadversions, especially as I found it was impossible, on account of my indispensable avocations in business, for me to prevent even those respectable persons I wished most to oblige, from being sometimes disappointed by unseasonable application.

With respect to the dispute, which has for some time subsisted about the superiour utility of high or low wheels, I presume that point to have been fully settled on the most permanent basis of mathematical reasoning and mechanical experiment. At least all those gentlemen, who have done me the honour to be present at my experiments, have been most clearly convinced of the truth of my observations already published. Indeed the contending advocates, who were of late so warm and violent in their mutual opposition, about high and low wheels, seem to have given up the bone of contention, as of little or no consequence. This they have done with great prudence, as the proprietors of carriages may be very safely left to their own experience, as their best guide in the use of high or low wheels; in which their own interest as individuals is chiefly concerned. Thus the members of the Committee of the honourable House of Commons, (appointed to sit on the bill now depending on the subject of the roads) who countenance the clause, admitting Mr. Bourne's rolling waggons, adopted by Mr. Sharpe, to pass thro' turnpikes toll-free, might be safely indulged in their opinion of their utility, provided they were duly limited to number of horses or weight. They would certainly tend to preserve
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the roads, if not so heavy as to depress their surface, or grind the materials used to repair them, into powder. But if they were thus limited in weight, no persons whatever, using carriages for hire or labour, would be prevailed on to adopt them: nay, were their weight unlimited, such persons, tho' prevailed on to make a trial of them, would not continue to use them long; while the experiment would in all probability turn out a very fatal one to the roads.

Not that this effect would be owing to the lowness of the wheels, but to the excessive weight of the load; which not even the breadth of the rollers would prevent from depressing the surface or crushing the materials of its reparation into dirt.

In the draught of moderate loads, the carrier or farmer may be left to his own sagacity: he will never use wheels so low as not to be readily able to surmount common obstacles, nor so high as to be necessarily so heavy as to bear any considerable proportion, in their weight, to that of his load. And of this he will be careful, for the sake of his own interest in the carriage and horses; without any regard to the preservation of the roads; which is not in general affected by the wheels being high or low.

The case is different with the use of broad or narrow wheels; in which the public good and private interest appear to be repugnant. Not that they really are so, to the degree that is imagined; or that the preservation of the roads requires the use of wheels so broad as to render the draught of loaded carriages so very tedious, troublesome and expensive as at present.

To

To set this matter in the clearest light I am able, I shall be obliged to go a little beyond the bounds of my particular profession; but as I have taken the best care I could to be well informed, as to those particulars which my own experience may not have fully reached, I flatter myself I shall commit no material error.

The truth is, that the wisdom of the legislature seems to have been misled, with regard to the principal object of attention. The design of every interposition of parliament, respecting the structure of wheel-carriages, has been professedly that of preserving the roads. But the preserving of the roads should have been a consideration subsequent to that of *making* them. We have highways in England, that have cost many thousands pounds repairing, as it is called, which never deserved the name of roads either natural or artificial, and yet if a moderate sum had been once expended in the making them, they might have for ages been kept in repair; and that comparatively for a trifle of what has been collected at the turnpikes.

Before we consider, therefore, how far carriages tend to destroy the roads, it is necessary to enquire a little into the state of the roads themselves and the modes of their reparation. By the *making* a *road*, I mean the constituting a firm and compact bed or plane of earth, stone, or other materials capable of supporting the weight of the load passing over it. Again, this plane should be on, or very near the surface; for if it lie too deep, however firm and compact it may be at bottom, it will be little better than no road at all.

In

In some places, nature itself presents such firm and compact planes on the earth's surface, capable of supporting the greatest weight, without yielding to the pressure; such are beds of stone, chalk, or any other compact hard substance.

These natural roads want no other fabrication or repair than that of making and keeping their surface nearly horizontal and dry; the only effect, the passage of wheel-carriages has over them, being that of grinding away the surface, and leaving a light dust which, the wind in general, readily dissipates. Such roads are of all the best, and are what the artificial roads should be made as nearly as possible to resemble. But these natural roads are in England few; our highways partaking of the different qualities of the various soils of the country they traverse; being a compound of loose stones, clay, marl, &c. It hence follows that, in making roads of such various compounds, various means should be used; and that even after all, there may be some soils so deep and of so loose a texture, that nothing but masonry or carpentry can ever form on them the compact bed or plane required.

Again, there may be others equally deep, but not so loose of texture, which may admit of being compressed, and if properly made, rendered consistent to a certain degree, so as to support a moderate weight; though they would effectually sink under an enormous one. What then must be the consequence of carriages of unlimited weight passing over such highways, that have not been even rendered so compact as to bear a moderate weight? Will their broad wheels improve the texture of the soil? Or rather,

will not their weight depress the loose and hard materials laid on their surface into the softer bed beneath ; which as the other subside, will of course rise up and render the way unpassable ? Will such highways as these, of which we have many in England, be improved by the passage of broad-wheeled carriages ; and that the more so in proportion to the weight of such carriages ; as is pretended, indiscriminately of all roads, by Mr. Sharp, and others ?

It is notorious, that in making new roads over light soils of deep strata, the materials themselves, when specifically heavier, will soon subside and afford endless room for the like repair : nay, where moderate loads only were to be sustained, it has been known that a few birch or heath bays have rendered the road more compact and lasting than ten times as many tons of heavy pebbles would have done. And yet, I am well informed that nothing is more common than for the surveyors of many such roads, to suffer heavy materials to be brought from a great distance, at a vast expence, to be swallowed up in the insatiable gulph of their highways.

Nothing I think, can be clearer than that on these bottomless roads, as they may well be called, the weight of the load is the most essential consideration ; and that the breadth of the wheel only serves more effectually to depress the hard materials used for repairing the surface, and of course to raise the softer marle or clay to the top : which will always be done irregularly ; the parts constantly giving way on the accidental side of least resistance. Thus
such

such roads might without any ruts, be soon made full of holes and rendered absolutely unpassable, by an attempt to repair them with rolling waggons of enormous weight.

As to the utility of broad-wheeled rolling carts or waggons to farmers or others, drawing moderate loads over fields, or unmade cross roads, it is not to be questioned; they are undoubtedly useful, if the wheels be not so low as to roll the earth up before them, instead of rolling over the earth and leaving it behind them. In this latter case, a farmer had better use a flat-bottomed sledge, turned up in front, without any wheels at all: and indeed he will find such a sledge, with a greater load, drawn over his pastures with less damage to the turf, and along dirty lanes in winter time full as easily and with less wear and tear, than is his narrow-wheeled cart, jolting from side to side in ruts full of holes a foot or two deep.——But the design of these animadversions respecting chiefly the preservation of the public roads, I shall confine myself to them.

We will suppose therefore that all these roads (as certainly our turnpike roads ought to be) are properly made: that is, so far as to have obtained a compact hard plane on or very near the surface, capable of supporting without partial depression the weight of any carriage that may be drawn over it: in which case it will, to all intents and purposes, answer the end of a natural road, as above described.

Let

Let us consider now what will be the effect of wheel carriages, passing along such roads. A firm bottom is admitted; but covered with how much dust or dirt? The dust indeed is of little consequence to obstruct the progress of the carriage, however inconvenient it may be to the horses feet, or disagreeable to the rider or driver. Dirt is more momentous and causes the roads to be what they call heavy; the meaning of which we may understand by the increased exertion of the horses, and decreased velocity of the motion of the carriages. Whence this dust or dirt? Most evidently it is formed by the grinding of the surface of the road, and the pulverizing of the materials with which it is repaired.

It is the accumulation of this pulverized matter on the firm plane of the road, that occasions them in wet weather to grow what is called deep, and to be cut into ruts by wheel-carriages: the latter of which, they will certainly be the more subject to, in proportion to the narrowness of such wheels, supposing the weight of the carriages the same. But, granting the road to be once well made, that is rendered so compact as to sustain the weights necessary to pass over it; such road will not be subject to ruts, till its surface be ground away and the dirt so fabricated, accumulated to a certain depth.

It may be said, that narrow-wheeled carriages, *ceteris paribus*, will cut deeper into the plane of the road than broad ones. Admitting this, it only serves to cause a greater difficulty in making roads for narrow-wheeled carriages than for broad-wheeled ones; and

and not to increase the difficulty of their preservation, when once well made.

This consideration also serves to shew that a stratum, which will admit of being made into a road for broad wheeled carriages, may not admit of being made into a road for narrow-wheeled ones of the same burthen. But what is to be inferred from this? Certainly nothing more than that where it is found impracticable to make and preserve a road capable of supporting narrow-wheeled carriages of a certain burthen, the breadth of their wheels should be increased, or the weight of the load diminished.

Take the public highways in general, however, throughout England, they may be made and preserved with proper materials, capable of sustaining wheels of a moderate breadth, bearing any weight calculated to be drawn by horses, with advantage to the proprietors.

Let us proceed then, to consider the effect of the passage of such carriages over a well-made road; the loose materials of whose surface are, as yet, stones or gravel, too large to be converted by water into mud, or dirt. In this case, such a road will resemble one of stones and gravel, laid over a stone or wooden-bridge, constructed by the mason or carpenter.

But whether carriages of broad or narrow-wheels would soonest pulverize the loose materials, and of course destroy such roads, has not, perhaps been duly enquired into*.

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* The reverend Mr. Homer, who was many years one of the commissioners of the roads in Oxfordshire and Warwickshire, and has written from experience on this subject, observes, with respect to broad wheels, that "an increase of weight, though supported

That heavy broad-wheeled waggons would, merely by their incumbent pressure, consolidate, or bind such materials together into one hard and compact surface, as hath been pretended by some, is altogether chimerical.

They might reduce those materials into smaller parts, but should they crush them into atoms, those atoms would have no stronger coherence, or be more firmly cemented together than before. On the other hand, they would only be the more easily blown or washed away.

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supported by more than a proportionably increase of surface, must produce an extraordinary consumption of materials, especially of such as are coarse, when used in the repair of roads; and though the variation will be different, according to the nature of the country, and the treatment they undergo, yet in all bad soils, it would probably be found upon enquiry to have been so great, since the encouragement given to broad wheels, as to be sufficiently alarming. At least, the writer can truly affirm that in those parts of his own neighbourhood, which fall more immediately under his observation, and are much frequented with these ponderous machines, it is now almost double to what it was before that event, though the roads in general are in a less eligible state; and supposing that the same track of management was to prevail for a course of years to come, it is difficult to conceive, where resources of materials will be found in future ages sufficient to keep the carriages of posterity above ground."

Again, the same writer observes that the use of broad wheels in general, is "very injurious to roads, which are only fortified to a certain breadth; that although their wearing is indeed confined more to the surface, and does not ordinarily operate to that depth, which heavy draughts constituted with narrow wheels do, yet upon the whole, it is greater and more destructive of materials; that of consequence, the expence of supporting roads since their establishment has been greatly enhanced; nor has that of carriage been at all lessened, notwithstanding the resources of posterity have been anticipated for them, and they have been favoured first with a total exemption from, and afterwards a considerable mitigation of, the payment of toll to which other carriages have been subject to."

This opinion of Mr. Homer, appears to be confirmed by that of the commissioners of certain turnpike roads in the western part of England, who, at a late meeting at the Devizes, unanimously declared their opinion, founded on experience, to be that, if a law should be made to permit broad-wheel waggons of any kind to pass through turnpikes for three years, without limitation of weight and number of horses, and toll free, the roads in that country would be entirely destroyed, and rendered impassable for any carriages whatsoever. See *An Enquiry into the Means of Preserving and Improving the Public Roads of this Kingdom*, by Henry Homer, A. M. rector of Birdingbury, in Warwickshire, and chaplain to the right honourable the Lord Leigh. Printed at Oxford, in the year 1767.

The commissioners, or surveyors, of the roads near London, have been frequently censured for raking off this flush, as it is called, and often carting it away; it having been thought by some, that such stuff should be raked up into the middle of the road, as being the best materials for its repair. But, however reprehensible the road-makers may be, in not laying the roads out in such a form as will keep them dry, by their spontaneously throwing off the pulverized matter, they are certainly excusable in not throwing it back upon the road, for whose repair it is become totally useless. That it is useful in making good causeways for foot passengers, whose weight is light, when raised so high and made so narrow as to throw off the water, is by no means a proof of its being proper to be laid again on the cart-ways. For without the commixture of some cementing ingredient, that would turn it into a kind of artificial stone, it would be still nothing but mud or dust. Heavy carriages require the surface of the roads, when made of loose materials to be of larger size than the particles of dust, and of firmer texture than clods of dirt.

Narrow wheels indeed might sooner displace the new materials, or cut deeper ruts in the best of our artificial roads, than broad wheels; but it is to be doubted whether they would sooner wear those materials out. At the same time, there are two important reflections to be made on this head; the one is, that the demolition of such materials will not follow the proportion of the weight of the load even of carriages whose wheels are of the same breadth: and the other, that it is not the number or multiplicity of light carriages which destroy the roads, so much as the excessive weight of the heavier few.

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The Pebbles, &c. generally used for repairing the roads, are brittle and are at once broken to pieces, by a single blow or crushed by a weight of a certain determinate force; altho' they might nevertheless have sustained ten thousand blows, or ten thousand times borne a weight, of very little less force, unbroken. Nor might they be a jot more liable to break after having withstood ten thousand shocks of considerable violence, tho' they might fly to pieces with the very next, of a very small additional force. *

It would be worth enquiry, therefore, under what weight of broad wheeled-carriages such artificial strata of stones and gravel laid upon bridges, begin very perceptibly to pulverize. We might then form some idea of the weight, which should be the *ne plus ultra* of that of all carriages passing along artificial roads.

It will be admitted that a broad wheeled carriage, bearing on a greater quantity of surface than a narrow one might be allowed to carry a proportionably greater weight, provided that surface were composed of a number of very small points of resistance; as in that case the narrow wheels will rest on fewer of those points: but, as, where the materials of the road are pretty large

* Mr. Homer observes that "if a certain degree of pressure, as for instance that of two Tons, be necessary to destroy the Contiguity of Parts of any one piece of material, or system of materials connected together, by a bearing upon each other, half that weight may repeatedly pass over such materials without producing any sensible effect; altho by the addition of the other half they will be immediately broken to pieces with a single impulse."

He might have added, as above observed, with the addition of even a very small portion of the other half. Indeed he expresses himself nearly to this purpose, in another part of his "work; where he says it is found by experience that Wheel-carriages in many circumstances act with more than double violence upon the materials and reduce many of them with one or two impulses to powder, which would stand the repeated shock of inferior weights."

large it will often hapen that a fingle ftone fhall equally bear the whole weight both of the broad-wheel and the narrow, it is plain the prefervation of the roads requires that the utmoft weight, to be carried by carriages of burthen, fhould be calculated for the broadeft wheels, of which the Structure of the carriage may conveniently admit.

From this flight furvey of the nature of our roads, and the manner in which they are affected by wheel-carriages, it is plain that it is the weight of carriages of burthen and not any other circumftance, which is the moft effential object of confideration, refpecting the damage they do the publick roads.

To this confideration, indeed, muft be added another, refpecting ftage coaches and chaises; many of which now carry very confiderable burthens; and by their running with a greater velocity than Carts and Waggon, acquire frequently an equal momentum; fo that they impair the roads confiderably, by breaking the materials on their furface. * Thefe, therefore fhould be particularly limited as to their weight; or perhaps it were better if,

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* Mr Homer indeed represents the friction of the wheels as being greater in proportion as the carriage goes slower. But, tho' the deprefion or rut made in a foft and ill-made road may be the greater in proportion to the time the carriage takes in paffing over it; the hard furface or loofe materials of a well-made road will not be ground or pulverized in that proportion. On the contrary, the fwifter the carriage goes the greater blow will the wheel ftrike againft every obftacle it meets. It is true that where thofe obftacles are very fmall, the velocity with which they are ftruck is very little, becaufe the point of the periphery of the wheel on which the carriage refts always ftands ftill. For it is to be obferved that as the axis of the wheel goes forward, its periphery turns the contrary way: Nor would turn round at all if the edge of the wheel and the furface of the road were perfectly fmooth. As it is in confequence of their roughnefs therefore that the wheel turns, the operation of its edge on the road may be compared to that

out of humanity, if not policy, to the poor horses, they were limited as to their velocity of motion, unless on urgent occasions.

On the other hand, as our stage-coaches and chaises should be restrained from running with such burthens so fast, our waggons and carts ought to be prohibited from carrying such enormous loads, as to make them creep so slow. The horses in the latter indeed are not so soon killed outright, but they are thence enervated, crippled and rendered otherwise useless while they live. *

It is indeed the weight of such carriages, the enormity of their load, and the length of their team, rather than any particular mode of Structure, as to high or low, broad or narrow wheels, which are the principal cause of the present tedious and expensive conveyance of goods by land carriage, as well as of an unnecessary multiplicity of droning draught horses.

It is not many years ago that the legislature very rationally conceived that the heavier carriages were loaded, the more they damaged

that of two dentated wheels, whose teeth, working into, necessarily rub against and consequently wear each other. Again, these teeth in roads of loose materials being loose, it follows that tho' the carriage goes forward the edge of the wheel frequently slides backwards as it turns round. This is remarkable in steep ascents; in mounting which the wheel of a carriage makes more turns than in going down hill the same distance. The materials of the road however are more crushed and pulverized by a carriage in its going down hill than in its going up.

* I cannot here forbear quoting a passage from Howel, a celebrated writer, who flourished near an hundred and fifty years ago; and speaking of this subject, says, " England may be called the Hell of horses; for their cars and carts are so unmeasurably laden, that their track doth not only spoil the pavements of the Streets and Highways as they pass, but oftentimes it seems to break the very heart-strings of the poor passive animal; inasmuch that of any nation that holy text is least observed by the English; a good man is merciful to his beast."

aged the road. On this principle the weighing engines were erected, and the number of horses in the team subjected to limitation. In the mean while the ruts, to which our ill-made roads were subjected by narrow-wheeled carriages, suggested the expedient of increasing the breadth of the wheels : an expedient indeed so far useful as it might serve to keep the surface of the road level; but a destructive one in admitting such broad-wheeled carriages to carry enormous burthens and be drawn by preposterous teams.

The consequences of this expedient not answering the expectations formed of it, the next suggestion was still more extraordinary than the former. This was that of making the wheels still a little broader, and then it was presumed the heavier the weight laid upon them, the more they would serve to preserve the roads. A presumption this, directly contrary to all former theory; and as inconsistent with former practice, as if it had been ingeniously discovered that the very means which had hitherto contributed to wear out the roads, were now become the only means to preserve them.

The parliamentary fiat, however, obliging the proprietors of stage waggons &c. to increase the breadth of their wheels, at a great expence, they very naturally sought to indemnify themselves by making use of the indulgence given them to increase their load: an increase aggravated on the team by the weight necessarily added to the wheels. The draught of our loaded broad-wheel-

wheeled waggons became thus in a manner absolutely impracticable, till the scheme of placing the horses abreast enabled the team to drag them forward with great difficulty at the rate of two or three miles an hour. To mend the matter as it thus stands; it is now projected by some to give still greater encouragement to heavy loaded waggons, by suffering them, with wheels or rollers of a certain breadth and diameter, to carry any weight and to pass toll-free! With what velocity such waggons carrying five, six or seven tons will approach a turnpike, time may shew; but that the commissioners will soon be tired of seeing them pass toll-free, it needs no great degree of sagacity to foretell.

The commissioners of our London pavements have as little reason to thank those gentlemen for their zeal, who, in order to save the keep of horses, recommend the use of waggons for the delivery of four or five chaldron of coals at once, instead of single chaldrons in separate carts. The use of fifty such coal waggons would do more damage to the pavement in one month, than the narrow-wheels of all the hackney coaches in London in a whole year. Not indeed by wearing away the surface of the stones, as is frivolously objected to the latter: but by depressing whole stones and sometimes many of them together; thereby raising others and reducing the whole surface into large ridges and holes; to which the London pavement, on account of its being so frequently taken up and relaid, will ever be subject, if carriages of enormous burthen are suffered to pass over it.

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The objection made to the narrow wheels of our hackney-coaches, because they have been found in some places to form perceptible ruts in the pavement, is not so very material. The public would have abundant reason to be satisfied, if our pavements wanted no repair till the stones were fairly worn out, or till the narrow-wheeled coaches made such ruts in them, as would be either very disagreeable or dangerous. On the other hand again, the obstinacy of our coach-masters is to the last degree absurd, in so strongly opposing a greater breadth of wheel for coaches, that are to run over a hard, impenetrable pavement; where, if the wheels be equally light, the advantage is on several accounts in favour of the broader. On a road indeed of loose pebbles, gravel, &c. it is not so; because a broad wheel will have more obstacles to depress or surmount than a narrow one; but this is not the case with indepressible pavements, on which, the difference between broad and narrow wheels of the same weight, is not very consequential.

It is greatly to be wished that all parliamentary injunctions for the preservation of the roads, which affect the structure and draught of wheel-carriages, might be so calculated as to answer the end both of the public and the individual. One reason for this is, that the law would not then be so liable to be evaded, as it is, when it clashes with private interest. This hath been particularly experienced in the various methods that have been taken to elude the spirit of the broad-wheel act. Another reason is, that individuals would thence be frequently convinced that the legisla-

ture, in consulting the public good, knows the interest of private persons often better than they do themselves*.

There are few people, even of those whose subsistence depends on the profits arising from land carriage, who would not think it more for their interest to keep an additional horse than an additional man: or that would be easily persuaded an additional driver might save them the purchase and keep of more than two horses. And yet, nothing is more certain than that two waggons built for carrying each a load under three ton, would be each drawn by four horses, two abreast, much faster and with more ease than one waggon, carrying six ton, would be drawn by ten, or even twelve horses. But then, it will be said, there is the expence of two carriages instead of one. There is so; but this expence is by no means double; again the two, carrying less weight, will be less subject to wear and tear than the one; the conveyance will be quicker, and consequently more profitable; the horses will not acquire that slothful rigidity of muscle, which renders them unfit

* Mr. Homer thinks nothing can be done effectually for the preservation of the roads, till the drivers of carriages are subjected to the severe controul of commissioners, surveyors and their deputies: the obstinacy and temerity of many waggons being such, says he, "that they require to be governed with as high a hand as negroes in the plantations." I suspect, however, that the carriage-drivers of this country will not easily submit to the correction of *negro-drivers*. Some gentler method must be devised, and the carriages and roads so constructed and laid out, as to put it out of the power of such drivers to injure the roads materially, without also injuring themselves. Nothing can be more pertinent or true than what this reverend gentleman himself observes, that "a proper construction of the carriages is certainly the most easy, and of all others perhaps the most effectual means of security to the roads; but then it should not be such a construction, as will enable them to carry *heavy*, but such a one, as will oblige them to carry *light* loads."

for any other purpose, and incapable of moving a pace much faster than that of a snail*.

In objecting to the greater original expence of two carriages than one, the proprietor acts the same part, as is played by those who should make our roads. They provide amply, and dispense lavishly, for the *repair* of what they are too penurious properly to *construct*†. What should we think of an architect, who should appropriate an immense estate to repair a house, on which he would not bestow a sufficient sum to have it properly built?

The thought of multiplying carriages and drivers, is, I know a powerful objection with those, who think the roads are to be both made and preserved merely by broad wheels. But, as the diminution of the weight of loaded carriages is the long-experienced and only effectual method of preserving the roads, it is proper that private interest, even should it a while apparently suffer, should give way to the public. As to the roads, I have already observed that it is not the multiplicity of carriages, but their weight and velocity that chiefly affect them. And as to the increase of drivers, I conceive, that they might subsist on the produce of the land now destined to the maintenance of the horses, they would serve, instead of: and I leave politicians to determine whether an increase of the number of hardy, well employed peasantry be most hurtful,

* It may be of some consequence to observe here also, that the faster the carriage goes, the more easily does it overcome obstacles, and therefore requires the less assistance from the horses, to continue its motion.

† Mr. Homer observes that there is a space of about five miles in a part of Warwickshire, on the great road leading from London to Chester, which in the years 1764, 1765 and 1766, cost repairing at an average 84/. 7s. a mile yearly; and that there were other parts of the same road, which would cost 121/. 17s. a mile annually!

hurtful, or beneficial to a nation. Not that this increase either of drivers or carriages, need be so great as may be at first imagined. For, as the journies would be made in at least two-thirds of the time in which they are at present, the carriages and drivers now in use would make three journies in the time they now make two.

From these considerations I conclude that, if some regulations, similar to the following, were to take place, respecting our turnpike roads and wheel-carriages, they would be found to answer the end both of individuals and the public.

AS TO THE ROADS,

1st. Let a firm and compact bed or plane be once formed, by the commixture of proper materials with the native strata, so hard as to sustain without depression four wheeled carriages, with six inch wheels, flat tire, bearing a load of three ton: or two wheeled carriages with like wheels bearing a ton and a half.

2d. Let the surface of such roads be made latitudinally a little convex and where necessary longitudinally waving; and, at the same time, be raised so high as to give room for the water to run off and leave, in the whole breadth, the surface dry.

3d. Let such roads be repaired with materials of the same specific weight as that of those with which they were first made.

4th. In very wet seasons, and when the materials of the surface are considerably pulverized, let the flush or mud be raked off the
road

road and carried away ; and by the first favourable opportunity its place supplied with fresh materials ; always preserving the road of the same height and form, to keep it dry.

5th. Let the tolls be adapted either to the number of horses or weight of the loaded carriage ; within the limitation of three ton to a four wheel carriage, and half that weight to a two wheeled one : no carriage being permitted to carry more than three ton unless in cases where the load cannot be divided ; and even then, not without special licence obtained of the Commissioners.

AS TO CARRIAGES,

1st. Let no waggons, or four wheeled carriages, have less than a six inch wheel, flat tire, nor any be permitted to weigh with their load above three ton. *

2d. Let no carts or two wheeled carriages of burthen have less than a like six inch wheel, flat tire, nor any be permitted to weigh with their load above one ton and a half.

3d. Let no stage-waggon or four-wheeled carriage of burthen be drawn by more than four horses two a breast, nor a loaded two wheel-carriage by more than two horses abreast or three in length.

4th. Let four wheeled stage coaches and chaises be restricted

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to

* I say three ton, because I conceive the lighter the weight the better for the road in every respect : not but that I believe, four horses two-a-breast, will be able, on account of the shorter length of team, to draw four tons as easily as eight horses in length would draw six ton, and as easily as eight horses two a breast would draw seven or even eight

to wheels at least three inches broad, flat tire, and to a burthen of two ton. All two wheeled chaises or carts to wheels of the same breadth and to a load of half the weight.

5th. Let pleasure-carriages and the coaches or chaises of private persons, be indulged with wheels of no more than two inches and a half breadth, flat tire; provided the four wheeled carriages with the burthen do not weigh more than one ton and a half and the two wheeled carriages more than fifteen hundred weight.

The reader will see that I have constantly in view the diminution of the weight of the burthens; with which our roads and pavements are at present so terribly indented, worn, and torn to pieces: for without such diminution, I am well persuaded no expedient we can make use of, however feasible in appearance, whether of carriages resting on cylinders, or on wheels rolling double surfaces, will ever effectually preserve them. At the same time and for the same reason, it is plain that it is the weight of the carriage, which is the chief impediment, in all cases, to the velocity of its motion.

It has indeed been doubted by some, whether what is advanced in the 7th. section of the 2d. part of my *Observations*, respecting a low wheeled carriage's keeping pace with a high wheeled one, after the friction of each is once overcome, be strictly true. To satisfy the publick, therefore, in this particular, as well as some others equally interesting and curious regarding the Structure and Draught of Wheeled Carriages, I have caused an apparatus to be erected, for demonstrating the truth of them experimentally.

Such

Such being the real state of the case, and the diminution of the weight of carriages in general a principal object both as to the preservation of the roads and the expedition of draught, I shall here beg leave to recommend to the publick attention the expediency of universally adopting wheels of the new construction, whose rim consists either of a single piece of wood, or two fellys only, bent by a newly discovered process, into a perfect circle, which is cased with a single hoop of iron : in consequence of which mode of construction, the grain of the wood is kept parallel throughout, its thickness considerably lessened, and the whole wheel rendered much lighter, and at the same time much stronger than wheels constructed of detached pieces of wood and iron in the usual manner.

It is on the same principle I may presume also to recommend the new-invented method of constructing wheel-carriages, so as to enable them to turn in a much less compass than in the common way : which is effected by a very light, simple and cheap contrivance, answering all the purposes of lowering the fore wheels, indenting the sides of the waggons, or even the apparatus of the crane neck for coaches and chariots, at once so burthenfome and expensive.

Specimens of these wheels and carriages of new construction may be daily seen at the Inventor's house, in St. Mary Axe ; or at Jacob and Viny's Wheel Manufactory in Black-friars road, near Christ-church, Surry : where such noblemen, gentlemen, or respectable artificers, who are curious also to see the above mentioned

tioned experiments may, for some time, have that opportunity, on Fridays, from the hours of twelve to three.

Orders for such wheels and carriages will be taken in at both places and duly executed. Artificers may also have licence of Mr. Jacob, the patentee, to make use of the contrivance for short-locking carriages, on paying the sum of two Guineas for each carriage they may so construct.

For a more explicit and particular account of these wheels and carriages, with a mathematical demonstration of their superiour utility, the reader is referred to the "Observations on the Structure and Draught of Wheel-carriages," before mentioned.

F I N I S.

